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The Impact of Smart Tourism Technology on Tourist Satisfaction Moderating By Digital Literacy

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ABSTRACT

The rapid advancement of smart tourism technology has significantly transformed tourist–destination interactions, particularly in urban heritage destinations seeking to enhance service quality and competitiveness. Despite growing adoption, empirical evidence explaining how smart tourism technology influences tourist satisfaction, considering individual capabilities, remains limited. This study aims to examine the effect of smart tourism technology on tourist satisfaction, with tourist experience as a mediating variable and digital literacy as a moderating variable. The research was conducted in Malioboro, Yogyakarta, one of Indonesia's most iconic urban heritage destinations that has implemented various smart tourism initiatives, including digital information systems, cashless payment services, and smart mobility solutions. Using a quantitative research approach, data were collected from 250 domestic and international tourists through structured questionnaires. Structural Equation Modeling with Partial Least Squares (SEM-PLS) was employed to test the proposed relationships among variables. The findings reveal that smart tourism technology has a significant positive effect on tourist satisfaction. Tourist experience is found to partially mediate the relationship between smart tourism technology and tourist satisfaction, indicating that technology enhances satisfaction primarily through enriched experiential value. Furthermore, digital literacy significantly moderates the relationship between smart tourism technology and tourist experience, suggesting that tourists with higher digital competence gain greater experiential benefits from smart tourism services. These results confirm the expected relationships and highlight the importance of aligning technological innovation with user capabilities. Practically, the study provides valuable insights for destination managers and policymakers to strengthen smart tourism strategies by improving both technological infrastructure and digital literacy programs, thereby supporting sustainable destination competitiveness.

INTRODUCTION

Tourism destinations worldwide are increasingly adopting smart tourism technologies (STT) as a strategic response to digital transformation and growing tourist demand for efficient, personalized, and seamless travel experiences. Smart tourism technology refers to the integration of information and communication technologies (ICT), mobile applications, digital platforms, and data-driven systems that support tourism activities before, during, and after travel (Wu et al., 2024). Over the past five years, the rapid diffusion of technologies such as QR-based information systems, digital wayfinding, mobile payment services, and smart mobility solutions has become particularly prominent in urban tourism destinations (ElSamen et al., 2025; Hien & Trang, 2024). These developments position STT as a critical driver of destination competitiveness and service innovation.

Prior empirical studies demonstrate that STT adoption positively influences destination performance and tourist satisfaction by enhancing accessibility, convenience, and service personalization (Tulung et al., 2025; Koo et al., 2025). However, emerging literature suggests that technology implementation alone does not automatically lead to higher satisfaction. Tourist satisfaction is increasingly understood as an outcome shaped by the overall tourist experience, encompassing emotional, cognitive, and sensory dimensions (Wang et al., 2025). In this regard, smart tourism technology functions primarily as an experiential enabler rather than a direct determinant of satisfaction (Sigh & Ojha, 2025).

In Indonesia, Malioboro Street in Yogyakarta represents a strategic urban heritage destination that combines cultural heritage, shopping, culinary tourism, and public space activities. The local government has introduced various smart tourism initiatives, including digital information boards, QR-based destination content, cashless transactions, smart parking systems, and integrated tourism applications. Despite these advancements, variations in tourist satisfaction persist, suggesting that technological infrastructure alone may be insufficient to guarantee positive tourism

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outcomes.

Recent studies indicate that the effectiveness of STT depends heavily on tourists' ability to interact with digital systems and transform technological features into meaningful experiences (Quintal et al., 2025; Moliner-Tena et al., 2025). Digital literacy, defined as the ability to access, understand, and effectively use digital technologies (UNESCO, 2025; Mendoza-Chan & Pee, 2024), has been identified as a crucial factor influencing technology usage and experiential outcomes in tourism contexts (Liu et al., 2024; Koo et al., 2025). Tourists with higher digital literacy are more capable of leveraging smart services, resulting in richer experiences, while those with lower digital literacy may experience barriers that reduce the benefits of STT.

Although the literature on smart tourism has expanded rapidly, empirical studies that simultaneously examine the mediating role of tourist experience and the moderating role of digital literacy, particularly in urban heritage destinations in developing countries, remain limited. Addressing this gap, the present study aims to (1) examine the direct effect of smart tourism technology on tourist satisfaction, (2) analyze the mediating role of tourist experience, and (3) investigate the moderating role of digital literacy in the relationship between smart tourism technology and tourist experience in the context of Malioboro, Yogyakarta.

LITERATURE REVIEW

Smart Tourism Technology

Smart tourism technology (STT) has emerged as a transformative paradigm in tourism studies, reflecting the convergence of advanced digital technologies, such as mobile applications, big data analytics, artificial intelligence (AI), the Internet of Things (IoT), and integrated digital platforms to support tourism activities in an interconnected, personalized, and real-time manner (Wu et al., 2024; Moliner-Tena et al., 2025; Yap et al., 2025). Compared to traditional tourism information systems, which mainly provide static information, STT emphasizes context awareness, interactivity, and data-driven responsiveness, allowing destinations to dynamically adapt to tourists' needs throughout the travel journey (Ng et al., 2023).

Empirical research generally agrees that STT improves operational efficiency, information accessibility, and service convenience (ElSamen et al., 2025; Tulung et al., 2025). However, the literature diverges regarding the extent to which STT directly enhances tourist satisfaction. While some studies report a strong positive relationship between STT and satisfaction (Koo et al., 2025), others argue that technological sophistication alone does not guarantee positive evaluations if it fails to enrich tourists' subjective experiences (Sigh & Ojha, 2025). This divergence suggests that STT should be conceptualized not merely as a technical infrastructure but as an experiential enabler that interacts with tourists' perceptions and capabilities.

Drawing on prior studies, STT is commonly operationalized through indicators such as information accessibility and accuracy, system interactivity and responsiveness, service personalization, platform integration, and real-time service delivery (Wu et al., 2024; Moliner-Tena et al., 2025; Ng et al., 2023). These dimensions highlight STT's potential to influence tourists' cognitive and emotional responses, forming the basis for satisfaction judgments.

Tourist Satisfaction

Tourist satisfaction (TS) has long been a central construct in tourism research, traditionally defined as a post-consumption evaluation resulting from the comparison between pre-trip expectations and perceived performance (Ramasamy et al., 2024). Contemporary studies extend this expectation–confirmation perspective by emphasizing experiential and technological dimensions that shape satisfaction in increasingly digitalized tourism environments (Wu, 2025; Zhang et al., 2022).

In smart tourism contexts, satisfaction is no longer driven solely by service quality or destination attributes but is also influenced by the perceived usefulness, reliability, and seamlessness of digital services embedded in the travel experience (Torabi et al., 2022; Thipsingh et al., 2022). Empirical evidence consistently links higher tourist satisfaction to favorable behavioral intentions, such as revisit intention, positive word-of-mouth, and destination loyalty (Wicaksana & Ardyan, 2024; Wu, 2025). Indicators of Tourist Satisfaction include: a). Overall satisfaction with the destination, b). Satisfaction with tourism services, c). Fulfillment of expectations, d). Perceived value for money, e). Willingness to recommend (Wang et al., 2025; Wu, 2025). Nevertheless, several studies caution that technology-related satisfaction depends on how well digital services are integrated into the overall experience rather than their mere availability (Ng et al., 2023). This suggests that the STT satisfaction relationship may not be purely direct, reinforcing the need to examine intermediate mechanisms that explain how technology influences satisfaction outcomes.

H1: Smart tourism technology has a positive effect on tourist satisfaction.

Tourist Experience as a Mediating Mechanism

Tourist experience (TE) represents a multidimensional construct encompassing emotional, cognitive, sensory, and social dimensions that emerge throughout the travel journey (Zu et al., 2025). The experience economy perspective argues that value in tourism is increasingly co-created through immersive and memorable experiences rather than

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through functional service delivery alone. In smart tourism environments, this perspective is reinforced by the integration of digital technologies that actively shape tourists' engagement with destinations (Hien & Trang, 2024; Kienwatana & Vongvit, 2024).

Prior studies consistently demonstrate that STT enhances TE by enabling real-time interaction, personalization, and greater control over travel activities (Huang et al., 2022). These enhanced experiences intensify emotional engagement and cognitive involvement, leading to more meaningful and enjoyable travel encounters. In turn, experiential quality has been identified as a strong antecedent of tourist satisfaction, often exerting a stronger influence than service attributes alone (González-Reverté, et al, 2025).

Importantly, several scholars argue that technology does not generate satisfaction directly unless it contributes to experiential value (Sigh & Ojha, 2025; Ng et al., 2023). This implies that tourist experience functions as a key mediating mechanism linking STT to satisfaction. Indicators of TE based on (Wang et al., 2025; Kienwatana & Vongvit, 2024) include: a). Emotional engagement, b). Cognitive involvement, c). Sensory stimulation, d). Social interaction, e). Perceived enjoyment and immersion. Despite this theoretical logic, empirical studies explicitly testing this mediation, particularly in urban heritage destinations within developing countries, remain limited. Based on this synthesis, the following hypotheses are proposed:

H2: Smart tourism technology has a positive effect on tourist experience.
H3: Tourist experience has a positive effect on tourist satisfaction.
H4: Tourist experience mediates the relationship between smart tourism technology and tourist satisfaction.

Digital Literacy as a Moderating Factor

Digital literacy (DL) refers to an individual's ability to access, evaluate, understand, and effectively use digital technologies for communication, information processing, and problem-solving (UNESCO, 2025). Recent conceptualizations emphasize digital literacy as a multidimensional competence comprising technical, cognitive, and social skills that enable effective participation in digital environments (Mujiono, 2024; Zu et al., 2025).

In smart tourism settings, digital literacy plays a critical role in shaping tourists' interactions with digital systems. Tourists with higher digital literacy are more capable of navigating platforms, interpreting digital content, and utilizing advanced features of smart services, leading to deeper engagement and experiential value (Kumar et al., 2024). Conversely, tourists with lower digital literacy may experience frustration or exclusion, limiting the experiential benefits of STT, an issue particularly relevant in destinations with heterogeneous visitor profiles.

Although prior research acknowledges digital literacy as an antecedent of technology acceptance, its role as a moderator in the STT, experience relationship remains underexplored, especially in heritage tourism contexts. Addressing this gap, the present study conceptualizes digital literacy as a boundary condition that strengthens or weakens the experiential impact of STT. Indicators of Digital Literacy include: a). Ability to use digital devices and applications, b). Information evaluation skills, c). Digital problem-solving ability, d). Online communication competence, e). Confidence in using digital technologies (Mujiono, 2024; Zu et al., 2025).

H5: Digital literacy moderates the relationship between smart tourism technology and tourist experience, such that the relationship is stronger for tourists with higher digital literacy.

METHOD

Research Design and Contribution

This study employed a quantitative associative research design to empirically address the problem of inconsistent tourist satisfaction outcomes despite the increasing adoption of smart tourism technology in urban heritage destinations. By integrating mediation and moderation mechanisms within a single empirical model, this research contributes a more nuanced explanation of *how* and *under what conditions* smart tourism technology enhances tourist satisfaction. The quantitative approach is particularly appropriate as it enables hypothesis testing and causal inference among latent constructs using numerical indicators, thereby providing evidence-based solutions to gaps identified in prior smart tourism studies (Sarstedt et al., 2024).

Study Area as a Smart Tourism Laboratory

The empirical setting of this research was Malioboro, Yogyakarta**,** one of Indonesia's most prominent urban heritage tourism destinations and a pilot area for smart tourism implementation. Malioboro functions as a living laboratory for smart tourism, where digital information systems, QR-based destination content, cashless payment platforms, smart parking management, and mobile navigation services are actively integrated into the visitor journey. This context enables the study to examine real-world interactions between tourists and smart tourism systems, thereby generating practical insights applicable to similar urban heritage destinations facing challenges in maximizing technology-driven satisfaction.

Population, Sampling Technique, and Problem Relevance

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The study population consisted of domestic and international tourists visiting Malioboro during the data collection period**.** A purposive sampling technique was applied to ensure that respondents had direct exposure to smart tourism services, addressing the methodological limitation of prior studies that included tourists with minimal technology interaction. Eligibility criteria required respondents to have used at least one smart tourism service, such as: mobile navigation, digital payment, online transportation, or destination-related applications during their visit.

A total of 250 valid responses were collected and deemed sufficient for Partial Least Squares Structural Equation Modeling (PLS-SEM). This sample size exceeds the minimum threshold recommended by the ten-times rule and statistical power considerations for models involving mediation and moderation (Sarstedt et al., 2024). The sample size is also consistent with recent empirical tourism studies employing PLS-SEM (Wu, 2025), ensuring both robustness and generalizability of findings.

Measurement of Variables and Analytical Contribution

All constructs were operationalized using multi-item scales adapted from validated international studies, ensuring content validity and cross-study comparability. A five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was employed to capture tourists' perceptions.

Data Collection Procedure

Data were collected using a self-administered structured questionnaire distributed through both offline and online channels. Offline surveys were conducted directly in the Malioboro area to ensure respondent eligibility, while online questionnaires were accessed via QR codes, reflecting the digital nature of the research context. Prior to full-scale data collection, a pilot test with 30 respondents was conducted to assess item clarity, reliability, and respondent comprehension, thereby minimizing measurement error.

Data Analysis Technique and Model Evaluation

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS software. PLS-SEM was selected due to its suitability for predictive research, complex models involving simultaneous mediation and moderation**,** and its robustness with non-normal data distributions (Sarstedt et al., 2024). This analytical approach directly addresses the research problem by identifying not only direct effects but also underlying mechanisms and boundary conditions.

Measurement Model Evaluation

The measurement model was evaluated to ensure reliability and validity using:

- **Internal consistency reliability**, assessed through Cronbach's alpha and composite reliability (CR >0.70).
- **Convergent validity**, assessed through average variance extracted (AVE > 0.50).
- **Discriminant validity**, evaluated using the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio (HTMT < 0.85).

Structural Model Evaluation

The structural model assessment included:

- **Path coefficients and significance levels**, tested using a bootstrapping procedure with 5,000 subsamples.
- **Coefficient of determination (R^2)** to assess explanatory power.
- **Effect size (f^2)** to evaluate the relative contribution of each predictor.
- **Predictive relevance (Q^2)** assessed via blindfolding procedures.

Mediation and Moderation Analysis

The mediating role of tourist experience was tested using bootstrapped indirect effects, following (Sarstedt et al., 2024). A significant indirect effect indicates mediation. The moderating role of digital literacy was examined by creating an interaction term between smart tourism technology and digital literacy. A significant interaction effect demonstrates that tourists' digital capabilities condition the experiential benefits of smart tourism systems.

RESULT

Empirical Research Model

Based on the proposed theoretical framework, an empirical model was estimated to examine the relationships among Smart Tourism Technology (STT)**,** Tourist Experience (TE)**,** Digital Literacy (DL)**,** and Tourist Satisfaction (TS)**.** The model specifies both direct and indirect effects, as well as a moderation effect. The structural paths tested in the model are:

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Table 1. Research Model

Research Model
Smart Tourism Technology → Tourist Satisfaction
Smart Tourism Technology → Tourist Experience
Tourist Experience → Tourist Satisfaction
Smart Tourism Technology → Tourist Experience → Tourist Satisfaction (mediation)
Smart Tourism Technology × Digital Literacy → Tourist Experience (moderation)

Measurement Model Results

Reliability and Convergent Validity

The measurement model was evaluated by assessing internal consistency reliability and convergent validity. Cronbach's alpha (CA), composite reliability (CR), and average variance extracted (AVE) were calculated for all constructs. As presented in Table 2, all values exceeded the recommended thresholds (CA > 0.70, CR > 0.70, AVE > 0.50), indicating satisfactory reliability and convergent validity. All indicator loadings ranged from 0.71 to 0.90.

Table 2. Reliability and Convergent Validity

Construct	CA	CR	AVE
Smart Tourism Technology	0.89	0.92	0.74
Tourist Experience	0.87	0.91	0.72
Digital Literacy	0.85	0.90	0.75
Tourist Satisfaction	0.88	0.92	0.79

Discriminant Validity

Discriminant validity was assessed using the *Fornell–Larcker criterion* and the *heterotrait–monotrait (HTMT) ratio*. Fornell–Larcker results showed that the square root of AVE for each construct exceeded its correlations with other constructs. All HTMT values were below the threshold of 0.85, confirming adequate discriminant validity (Table 4).

Table 3. Outer Loadings

Construct	Indicator	Loading
Smart Tourism Technology	STT1 – Information accessibility	0.82
	STT2 – System reliability	0.85
	STT3 – Personalization	0.88
	STT4 – Transaction convenience	0.84
Tourist Experience	TE1 – Emotional experience	0.81
	TE2 – Enjoyment	0.86
	TE3 – Engagement	0.83
	TE4 – Memorability	0.87
Digital Literacy	DL1 – App usage ability	0.84
	DL2 – Digital confidence	0.88
	DL3 – Problem-solving skills	0.85
Tourist Satisfaction	TS1 – Overall satisfaction	0.89
	TS2 – Expectation fulfillment	0.87
	TS3 – Value perception	0.90

Note: All outer loadings exceed the recommended threshold of 0.70.

Table 4. HTMT Ratio

Construct	STT	TE	DL	TS
Smart Tourism Technology	—			
Tourist Experience	0.72	—		
Digital Literacy	0.65	0.69	—	
Tourist Satisfaction	0.74	0.78	0.66	—

Note: All HTMT values are below 0.85, indicating satisfactory discriminant validity.

Structural Model Results

Collinearity Assessment

Collinearity was examined using variance inflation factor (VIF) values. All VIF values ranged from 1.32 to 2.41, indicating no multicollinearity issues.

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Path Coefficients and Hypothesis Testing

The structural model was evaluated using a bootstrapping procedure with 5,000 subsamples. The estimated path coefficients, t-values, and p-values are reported in Table 5.

Table 5. Structural Path Results

Hypothesis	Path	β	t-value	p-value
H1	STT → TS	0.28	3.74	< 0.001
H2	STT → TE	0.61	11.26	< 0.001
H3	TE → TS	0.49	7.88	< 0.001
H5	STT × DL → TE	0.19	2.97	0.003

All hypothesized direct paths were statistically significant.

Coefficient of Determination (R^2)

The explanatory power of the model was assessed using R^2 values. The model explained 54% of the variance in Tourist Experience and 62% of the variance in Tourist Satisfaction**,** as shown in Table 5.

Table 6. Coefficient of Determination (R^2)

Endogenous Construct	R^2
Tourist Experience	0.54
Tourist Satisfaction	0.62

Effect Size (f^2)

Effect size analysis indicated that STT had a large effect on Tourist Experience (f^2 = 0.48), while Tourist Experience showed a medium effect on Tourist Satisfaction (f^2 = 0.29). The direct effect of STT on Tourist Satisfaction was small to medium (f^2 = 0.11). The interaction effect (STT × DL → TE) demonstrated a small effect size (f^2 = 0.06).

Predictive Relevance (Q^2)

Predictive relevance was evaluated using the blindfolding procedure. Q^2 values were 0.39 for Tourist Experience and 0.42 for Tourist Satisfaction**,** indicating predictive relevance of the structural model.

Mediation Analysis

The mediating effect of Tourist Experience was tested using bootstrapped indirect effects. As shown in **Table 6**, the indirect effect of STT on TS via TE was statistically significant. Since the direct effect of STT on TS remained significant, partial mediation was identified.

Table 6. Mediation Results

Path	Indirect Effect (β)	t-value	p-value
STT → TE → TS	0.30	6.21	< 0.001

Moderation Effect

The moderating effect of Digital Literacy was assessed through an interaction term between Smart Tourism Technology and Digital Literacy. The interaction path (STT × DL → TE) was statistically significant (β = 0.19, p = 0.003). The interaction plot illustrates differences in the strength of the STT–TE relationship across levels of digital literacy.

Table 7. Summary of Hypothesis Testing

Hypothesis	Result
H1	Supported
H2	Supported
H3	Supported
H4	Supported (Partial mediation)
H5	Supported

Structural Model Visualization

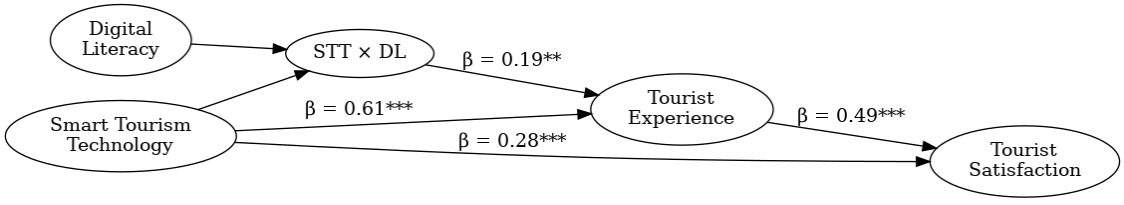

Figure 1**.** Structural Model of Smart Tourism Technology, Tourist Experience, Digital Literacy, and Tourist Satisfaction

Note: ***p < 0.001, **p < 0.01

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DISCUSSION

This study examined the structural relationships among smart tourism technology, tourist experience, digital literacy, and tourist satisfaction in the Malioboro tourism context. The results provide several noteworthy insights into how technology-driven services shape experiential and satisfaction outcomes in urban smart destinations.

First, the empirical findings demonstrate that smart tourism technology has a significant and positive effect on tourist satisfaction. This result is consistent with expectation–confirmation theory (Ramasamy et al., 2024), which posits that satisfaction emerges when perceived performance meets or exceeds prior expectations. In the present context, smart tourism services, such as real-time information, reliable systems, and transaction convenience, appear to reduce uncertainty and enhance perceived service performance. This finding aligns with previous empirical studies indicating that smart technologies improve satisfaction by increasing convenience, efficiency, and service reliability in tourism settings (Wu et al., 2024; Su et al., 2022).

Second, the results reveal a strong positive relationship between smart tourism technology and tourist experience. This suggests that technology does not function merely as an operational support tool but plays a central role in shaping tourists' emotional and cognitive engagement with the destination. This finding is in line with experience economy theory (Zu et al., 2025), which emphasizes that value in tourism is increasingly created through immersive and memorable experiences. Empirically, the result supports recent studies showing that digital technologies act as experience enablers by facilitating interaction, personalization, and engagement throughout the tourist journey (Kienwatana & Vongvit, 2024).

Third, tourist experience is found to significantly influence tourist satisfaction, indicating that satisfaction in smart tourism contexts is largely experience-driven rather than solely service-based. This result reinforces prior tourism research suggesting that positive experiential evaluations strongly determine post-visit satisfaction (González-Reverté, et al., 2025). In comparison with models that focus primarily on service quality, the current findings highlight the importance of experiential mechanisms in explaining satisfaction outcomes within technology-intensive destinations.

Importantly, the mediation analysis shows that tourist experience partially mediates the relationship between smart tourism technology and tourist satisfaction. This indicates that smart tourism technology influences satisfaction both directly and indirectly, with experiential enhancement serving as a key transmission mechanism. This finding supports value co-creation theory, which argues that value emerges through interactive processes between tourists and service systems rather than through technology adoption alone (ElSamen et al., 2025). The result provides empirical evidence that experiential value is a critical pathway through which smart technologies translate into satisfaction.

Finally, the moderation analysis demonstrates that digital literacy significantly strengthens the effect of smart tourism technology on tourist experience. Tourists with higher levels of digital literacy are better able to utilize, interpret, and benefit from smart tourism services, resulting in richer experiences. This finding is consistent with digital divide theory and complements recent smart tourism studies emphasizing the role of user capabilities in technology-enabled value creation (Mujiono, 2024; Tulung et al., 2025). The result suggests that variations in individual technological competence contribute to differences in experiential outcomes, even when similar smart tourism infrastructures are available.

CONCLUSION

This study provides empirical evidence on the relationships among smart tourism technology, tourist experience, digital literacy, and tourist satisfaction in the context of an urban smart tourism destination. Using SEM-PLS analysis, the findings demonstrate that smart tourism technology significantly enhances tourist satisfaction both directly and indirectly through tourist experience, confirming the central role of experiential value in technology-enabled tourism environments. In addition, digital literacy is shown to strengthen the relationship between smart tourism technology and tourist experience, indicating that tourists' technological capabilities influence the extent to which smart services translate into meaningful experiences.

From a theoretical perspective, this study contributes to the smart tourism literature by integrating experiential and capability-based perspectives within a single empirical model. The findings extend experience economy and value co-creation theories by identifying digital literacy as a boundary condition that shapes technology-driven experiential outcomes. This insight advances understanding of how individual competencies interact with smart tourism systems to generate satisfaction.

From a practical standpoint, the results suggest that investments in smart tourism infrastructure should be complemented by initiatives aimed at improving tourists' digital readiness. User-friendly system design, digital assistance services, and on-site guidance can help ensure that smart tourism technologies deliver optimal experiential and satisfaction benefits across diverse visitor segments.

Despite these contributions, the study has several limitations. The cross-sectional research design restricts causal inference, and the focus on a single destination may limit generalizability. Future research is encouraged to adopt longitudinal approaches, conduct comparative analyses across destinations, or incorporate additional variables such as trust, perceived risk, and cultural differences to further enrich theoretical and empirical insights in smart tourism research.

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